

GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, I.S.O., M.D., D.Sc. (CANTAB.), LL.D., F.R.S.,

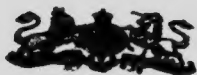
REPORT

ON

GRAHAM ISLAND, B.C.

BY

R. W. ELLS



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY

1906

DR. ROBERT BELL, F.R.S., &c.,
Acting Director, Geological Survey,
Ottawa.

DEAR SIR,—I beg to submit herewith a report on Graham island, the most northerly of the Queen Charlotte group on the Pacific coast. In the work of exploration particular attention was given to the coal areas of the interior, which were discovered twenty years ago and where several large and valuable seams are disclosed. These have been opened at three points, known as Camp Wilson, on the north, Camp Robertson, near the southern part, and Camp Anthracite, at the southern extremity of the field. The probable extension of these seams was indicated as closely as possible from the data available.

The exploration also included a boat voyage around the entire island, and a traverse across the central portion was made by way of Masset inlet, the Yakoun river and lake, and thence by trail across the coal basin to Skidegate. This was done in order to ascertain the eastern limit of the coal field and the character of the Yakoun river, which route it was hoped that a ready means of access to the coal seams might be found.

I have the honour to be, sir,
Your obedient servant,

R. W. ELLS.

GEOLOGICAL SURVEY OFFICE,
January 10th, 1906.

CONTENTS.

	PAGE.
Situation and size	7
Settlements	8
Communication with mainland.....	8
Harbours	9
Timber and Flora	11
Bibliography	15
Early explorations	16
The Yakoun river.....	17
Geology.	
Post-Tertiary	19
Tertiary.....	23
Cretaceous or Coal-bearing rocks	26
Skidegate.....	27
Slate Chuck creek.....	29
Cowgitz	29
Honna river ..	35
Camp Anthracite.....	35
Camp Wilson	39
Camp Robertson.....	41
Analyses.....	43
Igneous rocks	45

REPORT
ON THE
GEOLOGY OF GRAHAM ISLAND

QUEEN CHARLOTTE GROUP, B.C.

By R. W. ELLS.

The group of the Queen Charlotte Islands is situated off the west coast of British Columbia, and extends, roughly speaking, between longitudes $130^{\circ} 54'$ west, for the south part of Kunghit or Prevost island, and $133^{\circ} 9'$ for the northwest part of Graham island, at Frederick island; and in latitude between $51^{\circ} 53'$ and $54^{\circ} 15'$ north. It comprises a number of islands of which the principal, from south to north, are Prevost, Moresby, Graham and North, while, on the east coast of Moresby, are several others of considerable size, such as Burnaby, Lyell, Louise, &c.

A report was written in 1878 on the geological features of the group, by Dr. G. M. Dawson, with which was incorporated much information relative to the natural history, the Indians and other matters of general interest. Examinations were carried out by means of a small schooner, and were almost entirely confined to the eastern shores of the several islands, though a trip was made into the interior of Graham island, following the waters of Masset inlet from the north end.

The portion to which the present report chiefly refers is the most northerly, comprising Graham island, the largest of the group, and North island, at its northwest angle, these two forming the most northwesterly portion of the Pacific seaboard of the Dominion of Canada. These islands lie between longitude $131^{\circ} 36'$ (that of Rose spit, the northeast point of Graham island) and $133^{\circ} 9'$ (that of Frederick island, on the west coast), and in latitude between $53^{\circ} 8'$ and $54^{\circ} 15'$.

The only two settlements on Graham island are the Indian villages of Skidegate, at the southeast extremity, and of Masset, at the north end. The nearest shipping ports on the mainland of British Columbia are Ports Simpson and Essington, the distance from Masset to the former in a straight line being 85 to 90 miles and from Skidegate to Simpson 115 miles, or to Essington 115 miles. The sailing distances are of course somewhat greater than those given. The nearest land on the north is at Point Chacon in Alaska, distant about 45 miles.

Connexion with the mainland is made by means of a steamer calling at Skidegate once a month and at Masset once a year, though a more frequent service to the latter place is contemplated. At other times communication is had with the ports in British Columbia by sailing boats of about five tons burden, known as "Columbia river boats," which usually have fine seagoing qualities.

Graham island is much broader at the north end than at the south. Thus, from Rose point, on the northeast, to Cape Knox, at the northwest extremity, is fifty-three miles in a direct line; while from Lawn hill, near the southeast point, to the south entrance of Rennell sound, on the southwest coast, is only twenty-five miles across country. This is also practically the distance between Skidegate village and Hunter point, at the northwest entrance to Cartwright sound. The distance between Masset village on the north and Skidegate on the south is about 48 miles measured directly across the island, while from the north end of North island to the western entrance of Skidegate channel along the west coast is about 77 miles. The area of the island, roughly speaking, is somewhat more than 2000 square miles.

The northern interior of the island is accessible by water through Masset inlet, a deep and narrow tidal waterway, which, after a distance of seventeen miles, expands into a large lake-like sheet of water, with a length, from east to west, of eighteen miles, and a breadth north from the mouth of Yakoun river, which is near the southeast angle, of about seven miles. On the south side of this inland lake a narrow passage, through which the tide rushes with great force, connects with another inland salt water lake known as Tsooskatli, which is nine miles long, one to two and a half miles wide, and contains many small islands. The time of high water in this inland lake is about four hours and a half later than at Masset harbour.

To the north of the main expansion of Masset inlet there is a fresh water lake about fourteen miles long from east to west, with a maximum breadth of one mile and a half, known as Iintsua lake, which connects with the inlet by the Ain river. All these inland lakes are bordered by high ranges of mountains, including many cone-shaped peaks. All are composed of igneous rocks, portions of which are Pre-

Cretaceous, and part of later Tertiary age. By the Iintsua lake a waterway extends nearly across this part of the island, west of Masset inlet, a ridge of scarcely more than a mile in width separating it from the waters of the Pacific ocean in Kiokathli inlet, on the west coast of the island.

The island affords but few good harbours. On the west coast, the only really good seaport, which however has never been surveyed by the Admiralty, is near the southern end and is known as Rennell sound. It has a broad, clear entrance from the sea and extends inland about eight to nine miles, curving, towards the inner half, to the southward and thus forming excellent shelter from westerly gales. It can be readily recognized along the shore by the presence, at its entrance, of a bold hill, which rises somewhat abruptly from the beach on the south side to an elevation of over 1,000 feet. The inner end of this sound contains several islands, the largest of which was named Shields by Mr. W. A. Robertson, the original discoverer of the Graham island coal areas; from opposite this island a trail was partially constructed eastward for about four miles to the shores of Yakoun lake. This lake at the head of Yakoun river is practically on the line of contact between the coal-measure rocks of the east half of the island and the igneous rocks of the west coast. The trail passes over a ridge about 600 feet high or 390 feet above the surface of the lake, as measured by aneroid.

Kano inlet, sometimes called Cartwright sound, which is a few miles south of Rennell sound, extends inland for about seven miles. At its entrance the width from point to point is about three miles, which, three miles inland, narrows to two miles. There is a cove on the south shore with a small island where good shelter can be obtained for fishing boats, though the inlet, seaward, presents no other shelter from westerly gales. During the past season a fishing station for halibut was established here by Capt. Bradford. The inner half of the inlet is more narrow and terminates in two small coves, that to the southeast being bordered by high-peaked mountains which reach elevations of 3,000 to 4,000 feet, the summits, in July, being covered with snow. At the northeast angle of this inlet, the shores are lower, and a small creek enters from the east.

To the north of Rennell sound the inlets are small. The shores are uniformly rough, often with ragged ledges and good beaches are rarely seen. Several small islets are found near the entrance of the smaller indentations. The largest of these inlets, known as Kiokathli, is about twenty-five miles north of Rennell sound, but the entrance is bad and there are ledges inside which make it dangerous for vessels in its present unsurveyed state. Good anchorage for boats can be had in the

sheltered coves, but care must be exercised, owing to sunken rocks.

There are three principal islands on the west coast, the most southerly being Marble island, in the western entrance to Skidegate channel. Of the other two, the more southerly is known on the charts as Nesta or Hippo island and is about eighteen miles northwest of Rennell sound; the other, Frederick island, is twenty-six miles further north, or fourteen miles south of Cape Knox, which forms the northwest angle of Graham island. Hippo island has a length from east to west of about two miles, is high nearest the shore and slopes gradually to the west end. Shelter for small vessels can be found in the small bay on the east. Frederick island is somewhat similar in shape and size but the shelter is not so good.

The southern channel, between Graham and Moresby islands, is open to the sea on the west, with practically no shelter except Marble island. On the north side of this channel, known originally as Cartwright sound, are two bays; the outer one, due north from Marble island, extends inland for a mile or more; the other, near the entrance to the channel proper, is known as Dawson inlet and divides into two arms that extend inland for two to three miles.

The point north of Cartwright sound or the western entrance of Skidegate channel is very rough with jagged ledges and reefs stretching to the south-west for several miles. On Vancouver's plan, this is known as Hunter's point, but on Dawson's map this name is changed to Buck point, which is the name given by Vancouver to the north-west corner of Moresby island. The channel round the large island at the western entrance to Skidegate channel is partially dry, except at high tide, when it can be traversed by small boats only. Eastward of this island, Skidegate channel is also navigable for small boats only, and by these only at high water, owing to shallows and heavy tidal currents at what is known as the East and West narrows. The shores are rocky and bordered by high hills throughout the whole distance.

The eastern part of this channel opens out into South bay, and thence it gradually widens into Skidegate harbour, at the southeast corner of the island. This is practically the only harbour on the south and east coasts of Graham island or along the north shore till Masset is reached.

The western part of Skidegate harbour contains a number of islands, some of which are of considerable size, including Maude, South, Lena, etc. Around the head or western end of the harbour, near Cowgitz, the land is high, rising on the north into mountains 3000 to 4000 feet above the sea. On the Moresby island side, adjacent to the south, similar high peaks are seen, some of which are apparently perpetually snow capped.

The only harbours along the east coast east of Skidegate village are three shelters, for small boats only, at the mouths of small streams

and accessible only at high state of the tide. At low water they are entirely dry. These are at the mouth of Tlal river about twenty-five miles north of Skidegate; at a small creek south of Cape Ball; and at a small lagoon near Cape Fife, about eight miles south of Rose point. Inside the bends of the creeks at these places boats can lie safely sheltered from east winds, but are aground at low water. On the north side a similar high-water shelter for boats is found in Hiellan creek at Tow hill, ten miles west of Rose point. In bad weather, therefore, boat navigation along this coast is very dangerous and many lives have been lost in the vain attempt to reach a shelter in some one of these small harbours.

Along the north shore, Masset and Virago sound are the only harbours of consequence. The entrance to the former is somewhat obstructed by a bar on which the water has a reported depth at low tide of three fathoms, but the position of this bar is not fixed, owing to heavy storms and tidal currents. In the inlet, good water extends all the way to the lake expansion though there are heavy tidal currents throughout the entire seventeen miles of the narrow approach.

At Virago sound, about twelve miles west, the entrance is somewhat narrow but there is plenty of water, and once inside the points there is a perfect shelter and good anchorage.

These shores are practically uncharted except in the vicinity of Skidegate and, to some extent, at Masset, and the charts of the west coast are useless for navigation. No soundings have been taken, the coast line is merely sketched in, and is fringed in places for some miles seaward by jagged reefs, on which the seas are constantly breaking in rough weather. No reliable information could be obtained as to the character of this shore except that it was very rough, and no one could be found at the time of our visit who could act as pilot or who knew very much about this portion of the island.

The shores of the North island also are without harbours, but shelter from west winds can be found on the east side, near the entrance to Parry passage, which separates this island from Graham island. About nine miles farther east there is a good high-water boat harbour at the mouth of the Jalun river.

In the absence of a pilot, or of definite information as to the features of the west coast, we had to depend upon our own resources, aided by a rough sketch of the Crown Land plan of the island. The one man, apparently, who had been around the shores with Dr. Newcombe, of Victoria, some years before, had gone with the rest of his tribe to the mainland for the salmon fishing.

The whole island is densely wooded down to the sea-beach. There are no roads or cleared areas in any part and the only trails are those

from the shore of Skidegate harbour inland to the coal areas at Camps Robertson and Wilson, the first eight miles in length, and the second about the same distance farther north. The Robertson trail has been carried west to the shore of Yakoun lake about three miles distant. A horse trail is now being made between Skidegate post-office and the ranch at the mouth of Tllal river about 25 miles north. Communication between Masset and Skidegate settlements is made either by traversing the beach, a distance of over 100 miles, or by sail-boat round by Rose spit. A few horses are kept at Masset by the Indians and by the Rev. Charles Harrison, who has a small ranch called Delkatla three miles east of the Indian village, while a Mr. Hodge at the Tllal has a few head of cattle and horses and a fine piece of natural ranch-land. These animals pick up a living on the wild grasses along the borders of the beaches or in glades in the woods, while on the ranch lands at Masset and Tllal considerable quantities of hay are made from the wild grass on the marsh lands along the creeks. A number of fine cows are also kept at these places and the Indians, both at Masset and Skidegate, own a quantity of cattle which run practically wild in the woods for a good part of the year.

In the northeast part of the island, towards Rose point and in rear of Cape Fife, there is also a considerable herd of wild cattle, which are now being hunted down for the sake of the meat, which is taken to Port Simpson or to one of the Alaskan ports for sale. This herd was reported as very large, but from close inquiries, it appears that the number of animals at present in this part of the island in a wild state is probably under one hundred.

Owing to the generally dense forest, ranching can be carried on, with any chance of success, only at widely separated points. With the exception of the above named, no other attempts have yet been made at ranching on Graham Island, though on the adjacent island, (Moresby) at Spit point across from Skidegate, a ranch of large size has quite recently been started under favourable conditions. Owing to the fact that severe winter weather never visits these islands, the stock can be kept in the open all the year round.

The islands of the Queen Charlotte group held, some thirty years ago, a large Indian population, variously stated at from 5,000 to 7,000 persons (Haidas), who were scattered in villages along the entire coast line. This number has gradually decreased—through sickness or removal—and the number of persons in this group is now reported to be about 700. Gradually, also, the entire Indian population has removed from the once widely separated villages, the remains of which can still be seen at many places, until they are all now concentrated at the village of Masset at the north end of Graham island, and

at Skidegate at the south end. At both places the Indians are comfortably situated, having good houses and boats, a co-operative store and a factory for the manufacture of dog-fish oil under their own control and management (the last two industries being located at Skidegate), while there is another factory, usually known as the oil-works, located at Skidegate post-office, two miles west of the Indian village, where employment can also be had, if desired. In point of comfort and physical well-being, the Indians of this island appear to be very fortunate. They are also quite musical and there is a good brass band, entirely managed by themselves, in each village. During the summer months—from the middle of June to the middle or end of August—the island is practically deserted by the Indians, the whole population migrating to the mainland of British Columbia, where they are employed in the numerous salmon canneries that abound along the coast from the Portland canal south to the Fraser river. In ordinary seasons, the earnings for this time are sufficient for the family's comfort and support for the rest of the year, so that, with the exception of providing what few fish are required for home consumption, there appears to be but small incentive for hard physical work.

During the winter months certain members of the tribe engage in hunting, principally the bear, which appeared to be quite numerous, especially in the country around the Yakoun river and lake, and in the southern half of the island. Of other large animals there appears to be a scarcity, though the Rev. Charles Harrison of Masset asserts that caribou have been found in the country adjacent to Virago sound. As very few white persons have ever attempted to penetrate the dense forest of the interior the presence of this animal might easily escape notice. During our boat journey along the north shore, west of Virago sound, several forms, like deer, were observed feeding along the beach. It was supposed at the time that these might be wild cattle, but as the herd of these is, so far as known, confined to the area east of Masset inlet, and as no trace of them has been reported from this part of the island, it is quite possible that the animals seen may have been deer. Our boat was, at the time, too far from the land to definitely determine this point.

The forest growth is remarkable in several ways. Apart from its dense character, the trees are often very large, reaching, in some cases, a circumference of thirty feet, with a height of 250 to 300 feet. According to Bull. No. 21 (U.S. Dept. of Agriculture, Washington,) North American fauna, 1901, Osgood, the principal species of trees which occur in the island are the Sitka spruce (*Picea sitchensis*), the Western hemlock (*Tsuga heterophylla*), the alpine hemlock (*Tsuga mertensiana*), the Giant cedar (*Thuja plicata*), the yellow cedar (*Chamaecyparis nootkatensis*), the northwest coast pine (*Pinus con-*

torta) and the Pacific yew (*Taxus brevifolia*). In addition to these, the alder (*Alnus oregonia*) grows to a large size, often having a diameter of from 12 to 20 inches, or even larger; the willow (*Salix scouleriana*), is often of fair size, and the Oregon crab-apple (*Pyrus rivularis*), grows along some of the inland streams and also on the beaches, and forms a great impediment to travel, owing to its spiky or thorny character.

Among berries, the most abundant seen by us were the Sallal (*Gaultheria shallon*), the Salmon berry (*Rubus spectabilis*), especially plentiful and laden with large yellow and red berries, the Elderberry (*Sambucus racemosus*), the Dogwood (*Cornus occidentalis*), Honeysuckle (*Lonicera involucrata*), and the wild currant (*Ribes*). Throughout the forest, progress is greatly impeded by thickets of Sallals and Salmon berry, by a thick growth of the Devil's club (*Echinopanax horridum*), and by large quantities of the rank skunk cabbage (*Lysichiton kamschatcense*), the fleshy succulent roots of which are a favourite food of the bears, and whose leaves sometimes measure three feet in length by eighteen inches in breadth. The great amount of moisture which prevails for a large part of the year develops an abundant undergrowth of shrubs and ferns, that often occur in great clustering bunches and are almost impossible to penetrate. Through many centuries of decay large numbers of huge trees have become imbedded in the soil which is probably largely composed of decayed vegetation; the usually very rough ground surface is often covered with large prostrate tree-trunks from five to eight feet in diameter, which lie in all directions and are thus practically impassable. Upon these fallen trunks, numerous examples of wonderful forest growth are seen in the presence of large cedars or other trees which grow entirely from the upper surface of the fallen timber, the huge roots of the latter growth clasping the trunk beneath. The newer tree sometimes has a diameter of four to six feet and a height of 200 feet; the prostrate log, when cut into, is in many cases, apparently quite sound in spite of the long interval that must have elapsed during the growth of the newer tree.

The whole of the island west of Masset inlet in the northern half, and a line drawn through the valley of the Yakoun river and lake and thence to the shore of Skidegate harbour east of Slate Chuck creek, is occupied by igneous rocks, and is exceedingly rough, with many mountains, whose peaks rise to elevations of 2,000 to 5,000 feet above the sea. Some of these are cone-shaped and snow can be seen in their summits for the greater part of the year. These hills are all densely wooded, except where occasional patches of heath appear along the sides on their upper portions. It may easily be imagined that the whole of the country in this direction is exceedingly hard to traverse or to prospect.

East of the line referred to through the centre of the island the surface is comparatively low, and over large portions quite level. Forest fires have destroyed much of the original timber growth, more especially throughout the eastern part, but the second growth is dense everywhere. There are no tracts of clear land, but extensive swamps are found. Several comparatively low ridges are seen in the northeast corner of the island which extend southerly from Tow hill and in rear of Cape Fife, and these may represent masses of igneous rocks of which however no definite statement can be made owing to the absence of outcrops in that area; but masses of basaltic rock of the later Tertiary age, in places columnar in character, are found at Tow hill on the north and at Lawn hill on the southeast coast. To the north of Skidegate high ridges are seen, which, according to the chart, reach a height of 1,400 feet. These are in part igneous and in part a conglomerate.

The exposed rocks of this eastern area are generally sandstone and shale of Cretaceous and Tertiary age. Rock outcrops are seldom seen except on a few of the streams in the southern part of the island, while merely surface exposures are rarely visible owing to the thickness of the soil covering. Some of the streams cut deep channels, but the banks are usually of sand and gravel with occasional thick beds of clay. These streams are difficult to traverse owing to the quantity of drift tree trunks and the abundance of boulders, which make walking very dangerous. In the Yakoun river the drift trees render the stream impassable for long distances and in places entirely choke up the channel.

The literature relating to the island may be briefly stated. It has been reviewed by Dr. J. F. Whiteaves in his Report on Mesozoic Fossils, 1876, and later by Dr. G. M. Dawson, (Rep. 1878-79, pp 8 to 14.) It extends from the expedition under Juan Perez in 1774 down to Pender's survey of Skidegate inlet in the "Hecate" in 1866. On the part of the Geological Survey, Mr. James Richardson, in 1872, paid a visit to the south side of Graham island, and examined the deposit of anthracite at the west end of Skidegate harbour, known as the Cowgitz mine, the report on which is contained in the volume for 1872-73. In 1878, Dr. G. M. Dawson, in the small schooner "Wanderer" of 20 tons, examined the eastern shores of the several islands in the group as far as North island, and also the inland waters of Masset inlet. The western shores were not, however, visited on this trip. The report on this expedition will be found in the Annual volume for 1878-79.

Various papers relating to the Archaeology and Natural history of the islands have appeared from time to time between the years 1868

and 1901. Among the excursions undertaken for this purpose Dr. C. F. Newcomb made two voyages in 1895 and 1897, with reference principally to archaeological researches among the Haida Indians. Collections of fossils were made from a number of places, and have helped to more definitely settle the age of the sedimentary rocks of Graham island, though collections had previously been made by Mr. Richardson and by Dr. Dawson. These collections are all from points along the shores.

The interior of the island was however almost entirely unexplored, the only information relative to it being obtained from the brief trip of Dr. Dawson in 1878. In 1885 Mr. W. A. Robertson, of Victoria, while making an exploration on behalf of the Provincial Government in connexion with the timber resources of the island, ascended the Yakoun river to the lake at its head. Thence, crossing the country he reached the harbour of Skidegate at the mouth of the Honna river. In this trip, while examining some of the small streams to the east of the Yakoun, pieces of bituminous coal of excellent quality were observed, and on tracing these upward to their source a seam of large size was discovered which was afterward opened up to some extent along the outcrop and is known as the "Wilson seam." Farther to the south drift coal was also seen on the east branch of the Yakoun which flows into the main stream a short distance below its exit from the north end of the lake. Tracing these pieces to their source, another large and valuable deposit was disclosed, situated about three miles east of Yakoun lake and some eight miles inland from the mouth of the Honna. This outcrop was subsequently styled the Robertson seam—after its discoverer. This seam has also been opened up along the outcrop for a short distance, under the direction of several mining engineers who have visited the locality at different times in the interest of the owners.

Owing to the desirability of ascertaining something definite, if possible, as to the structure of this coal field, it was decided early in 1905, by the Acting Director of the Geological Survey, to send a party to Graham island for that purpose. In the carrying out of this work an examination was made of the interior as far as was possible, and of the entire shore line, starting from Skidegate and going west through the boat channel which separates Graham from Moresby islands, and thence by the west coast to the north end of North island. From this point the north shore was examined, including the harbour of Virago sound where lignite had been reported as occurring. A trip was taken inland to the heads of the several lake expansions. At Masset inlet the party divided. My assistant, with one man, ascended the Yakoun river to the lake, partly by small canoe and partly on foot through the woods, whence they followed the trail

to Robertson Camp and thence out to Skidegate by way of the Honna trail. This was a very difficult trip, owing to the low state of the water in the river, and the number and extent of the log-jams which compelled them to abandon the canoe before the lake was reached.

Returning with the boat to the mouth of the inlet the coast was followed to Rose point, where much difficulty was experienced in rounding Rose spit and where one boat was lost owing to heavy seas. A gale from the west also detained the party for ten days at Tow hill. Thence the shore was followed south to Skidegate.

The journey around the coast was made by means of a Columbia river fishing-boat having a length of 25 feet over all, by seven feet beam. These boats are fitted with centre-boards and carry a mainsail and jib. They are usually very seaworthy and are fairly easily handled in calm weather, being arranged for four oars. The carrying capacity is about five tons.

This plan of exploration, the best that could be had at that time, is far from satisfactory on a coast like that of British Columbia, abounding in deep fiords, strong tidal currents, and subject to long intervals of calm weather, alternating with heavy gales. The necessity of seeking a safe shelter every night, especially along an uncharted coast, without a pilot familiar with the shores, involved a certain amount of anxiety, especially when on the west and north coast, where the danger from heavy westerly or northerly gales is great, owing to the scarcity of sheltered coves or harbours. For this kind of exploration, a good staunch gasoline or steam launch is almost necessary, would obviate many exasperating delays, and, on the whole, would be more economical—to say nothing of the more important element of safety—than the ordinary sailing craft.

The rivers on the islands are few and, generally, of small size. The Yakoun is the largest, connecting Yakoun lake in the southwest part of the island with the head of Masset inlet. This river has a length of about eighteen miles in a direct line, though, with the windings in its course, the actual length is probably not far from twenty-five miles. It flows, largely, through banks of sand or clay for the lower half of its course, but several rock ledges outcrop in the upper portion. No detailed survey of this stream had ever been made and but little information could be obtained as to its character, beyond the fact that in spite of considerable obstruction in the channel, due to drift logs, it had been ascended, at certain stages of water, in small canoes. A compass survey was made by my assistant during the latter part of July, the distances being determined by pacing where possible or by estimation where pacing was impracticable. The water was very low, and the canoe could not be taken to the lake, but

the several log-jams were located, and measured, and the positions of the shallows were fixed. The log jams in the river are over thirty in number, some of large dimensions.

The first jams were found about two miles from the mouth of the stream and, in the next stretch of two miles, ten jams were located, including several logs with diameters of from 12 to 30 inches. The next three miles were comparatively free from logs, but the stream was very shallow, with banks of clay and sand. Jams are frequent in the next three miles, ten being seen, several of which were marked as "bad," with drift logs up to 60 inches in diameter. In the next six miles, up stream, these jams are comparatively rare; occasional ledges of sandstone outcrop, cutting in places directly across the river. In the next stretch of three miles there are ten log jams, several of which are very bad, to within about four miles of the foot of the lake where it was found necessary to leave the canoe, the last distance to the lake being almost clear, with the exception of one large jam. For a couple of miles there is dead water below the outlet. At about six miles below the lake, the stream flows through a channel cut in the sandstone for a distance of about half a mile, the passage being from 12 to 20 feet in width.

Many of these jams are very old and solid, the lower trees being partially buried in the sand. At a high stage of water some of them would be covered sufficiently to pass boats of two to three feet draft, but the greater part would have to be removed to obtain a passage for small boats from salt water to the lake. They could, however, quite readily be removed by proper appliances, when the water in the river is high by means of a small steam engine, a tug or steam scow and dynamite for the large logs. Besides the log jams, the number of shallows in the stream would seriously interfere with navigation except in high water stages.

Owing to the generally low condition of the banks and the almost impenetrable tangle of roots, small bush and rank vegetation, it is almost impossible to traverse this part of the country during the summer months, the water in time of flood being dammed back and spreading through the surrounding flat country in small and swampy channels, which in time also become choked with drift wood and form an impassable jungle.

The importance of this stream as a means of inland communication is however very considerable. In any attempt to work the coal seams, especially at the Wilson camp, the facilities of transport by this route—if it could be rendered navigable—would be much greater than by trails cut from Skidegate, a distance of seventeen miles. With the

jams removed and the shallows dredged at the worst points it would be possible to take up light draft stern wheel boats or scows as far as the mouth of Wilson creek, which is only a mile from the outcrop of the coal; or to the lake itself, where the east branch of the Yakoun comes in and where boring operations should be carried on in the valley of this stream to the north of the Robertson camp outcrops. In this way, also, machinery for sawmills which will be very necessary for all contemplated mining operations, can be placed on the ground in the vicinity of both camps with comparative ease.

GENERAL GEOLOGY.

The formations found on Graham island may be considered under four heads:—

I. Post Tertiary; including sands, gravels, and clays, the latter often holding marine shells and pieces of lignite.

II. Tertiary; comprising shales, sandstone and conglomerate with beds of lignite, fossiliferous.

III. Cretaceous; shales, sandstone and conglomerate, with thin limestones, and with large deposits of bituminous coal which sometimes passes into anthracite; also fossiliferous.

IV. Igneous rocks comprising Pre-Cretaceous and later Tertiary.

POST-TERTIARY.

The general aspect of the sands, clays and gravels has been well described in the Report by Dr. G. M. Dawson, 1878-79, and lists of fossils collected from them at different points have been given. It will be necessary therefore merely to give briefly the leading features relating to the formation.

Along the east and north coasts the surface deposits of clays and sands are best exposed. The south and west coasts are rocky and generally rough, with high hills rising almost from the sea shore and the Post-Tertiary deposits, if ever deposited, have been largely removed.

Along the east and north shores, which are low, rock outcrops are rarely seen east of the entrance to Masset inlet. Along this part of the coast, sands and gravels abound, and are frequently underlaid by a hard tough bluish-grey clay, which at a distance resembles a hard grey sandstone and from the lower part of which collections of marine shells were made by Dr. G. M. Dawson in 1878, and were determined by Dr. J. F. Whiteaves.

These beds of clay and sand are exposed at a number of places, not only along the shore line but in the interior. Their distribution has been wide-spread. Among places where their relations can be well studied may be mentioned the following:—

The shore north of Lawn point; Cape Ball and for several miles north; the entrance to Masset inlet, opposite the village; the east shore of the inlet at Watoun river, eleven miles above the village; at Echinus point about two miles west of the mouth of Yakoun river on the south side of the Masset inlet expansion; the Mamin river, (a small stream flowing into the inner Masset expansion known as Tsooskatli); on the north shore at Mary point just outside the narrows of Virago sound; the shore inside, opposite the old Kung Indian village; and at Lignite brook on the east side of Naden harbour.

At all these places, the characters of the deposits are practically the same. A section made of the occurrence at Mary point gives in descending order:—

Sandy layers, upper shell bed	3 ft.
Sands with pebbles having the aspect of a well solidified conglomerate	5 "
Stiff grey clay, with pieces of lignite and thick deposits of shells many of which are of large size.	3 "
Beach with lignite pieces.	

Among the species of shells found in these deposits those collected at Watoun river, in Masset inlet, may be given as fairly representing those found elsewhere. They include

Hemathyris psittacea, Lim.

Modiolaria Nigra, Grey.

Saxicava rugosa, Lamarck.

Puncturella galeata, Gould.

Balanus ?

A very common shell at most of these places is the large variety of the clam, still found in great quantities and used for food, known as *Schizochærus Nuttalli*, some specimens of which measure seven inches by five.

An interesting feature in these clays is the frequent occurrence of lignite. The quantity observed is usually small, and from the decay of the banks it is often picked up along the shore, leading to the supposition on the part of some people that its presence in such places may indicate the occurrence of beds of this material in workable quantities. In no case where seen is this indicated by the conditions of deposit. The largest pieces found were on the bank of a small creek on the south side of Masset inlet opposite the Indian village, where the lignite occurs in pieces up to four or five feet long and with a thickness of several inches. It is of very inferior quality and unsuitable for fuel. The occurrence at Lignite brook, in Naden Harbour, is

similar, but the amount of observed lignite is much less, the pieces being merely fragments picked up on the beach. At neither of these places are any sedimentary rocks other than clay exposed.

At the outcrop on Manin river, which is the most inland location observed, the following fossils, taken from Dr. Dawson's list occur; (Rep. 1878-79, p. 95 B):—

Macoma nasuta, Conrad.

Saxidomus squalidus, Desh.

Tapes staminea, Conrad.

Lucina filosa, Stimpson.

At the locality on Naden river which enters the head of Naden harbour (Virago sound) the following species were observed in a bank about fifteen feet high:—

From the lower part of the bank:—

Saxidomus squalidus, Desh.

Tapes staminea, Conrad.

Macoma sp.

Nassa mendica, Gould.

Cryptobranchia concentrica, Midd. (*Lepeta coecoides*, Cpr.)

Tornatina eximia, Baird.

Littorina Stichana, Phil.

From the upper part of the bank the following were obtained:—

Saxidomus squalidus, Desh.

Tapes staminea, Conrad.

Cardium Nuttalli, Conrad.

Purpura crispata, Chemn.

The country east of Masset inlet is usually low, or broken with occasional ridges of no great elevation. It is large'y drift-covered, and rock outcrops are practically unknown. Even the streams, which are short, are cut in sand and gravel, so far as they have been examined. On the north shore, from Masset to Rose point there is nothing but sand, gravel and boulders with the exception of the rock outcrops at Tow hill, and at two places between this point and the entrance to the inlet. The sands are often blown into great ridges which have invaded the edge of the forest growth that skirts the shore. Along the portion between the mouth of Hiellaon river, at Tow hill, and Rose point, the upper part of the beach is composed of great quantities of rounded pebbles, mostly of igneous rocks, while the outer portion of the point consists of great masses of blown sand or dunes. These dunes continue

south from Rose point on the east side for several miles, and, with the exception of the clay outcrops already noted near Lawn hill and Cape Ball, the sandy character predominates. Between these two places, there are great quantities of boulders which extend seaward for some distance and have to be guarded against in boat navigation at low water. At the high-water harbour of Cape Fife, where a shelter for boats is formed by a projecting gravel bar, which extends northward parallel to the coast for several hundred yards, the banks are stratified sand and gravel which overlie clays containing layers of pebbles and, in places, shell beds, to a height of ten feet above high-water mark. A small lake close to the shore at this place is partly surrounded by a stratum of peat which overlies the sand and gravel.

This portion of the coast has assumed some importance in recent years owing to the presence of gold-bearing black sands that extend southward from the vicinity of Cape Fife. They were traced in this direction nearly to Lawn hill. During the past season (1905) a number of mining claims were taken up along the shore near the former place, and it is proposed to erect a washing plant for the extraction of the gold. The original source of the metal is unknown, but the present accumulation of the black and ruby sands is evidently due to the destruction of the sand banks along the shore and not from any rocks in place. The thickness of the sands, so far as could be ascertained, did not appear to be great.

Rose point, which terminates seaward in Rose spit, is one of the most dangerous places, as regards navigation, on the whole island. The sand dunes on the former extend northward for some miles and form a long area of shallows upon which, in any but a south wind, tremendous seas occur. There are occasional gaps in the sand of the spit, through which boats can pass at certain stages of the tide in calm weather, but at other times boats and canoes rarely make the attempt and much delay is often experienced before a safe passage can be effected. During our trip round this point we were delayed for ten days in the high-water harbour at Tow hill owing to the impossibility of launching a boat in the surf that broke all along the shore, and many lives have been lost in the attempt to round the spit, or through being caught in heavy weather on this part of the coast.

Indications of ice movement were observed at only one place around the island. On the shore two miles west of Skidegate post office striae were seen having a direction of N. 40° E. or in the line of Skidegate channel, the result probably of local ice movement from the high hills to the west.

TERTIARY.

The Tertiary rocks of Graham island are divisible into two parts, viz.: the sedimentary, comprising sandstones, shales and conglomerates, with occasional beds of lignite; and the igneous, which form a large part of the western coast north of Rennell sound, and are exposed at intervals along the north shore, west of Masset inlet. The rocks of the second division will be discussed under the head of Igneous.

The general distribution of the Tertiary sediments must be, to some extent, inferred. So great is the mantle of drift, and so extensive the forest growth, that rock outcrops are rarely seen. From the evidence obtainable it would appear that the part of the island east of a line drawn from a point a short distance east of the Indian village of Skidegate, across country to near the village of Masset, is underlaid by these rocks, outcrops of which are seen at Chinookundl brook, between Skidegate and Lawn hill on the south, and at Skonun point, about four or five miles east of Masset entrance. These rocks are also seen on the north shore of Tow hill, underlying the trap rocks which form that headland, and on the shore of Yakan point, two miles west. On the east coast no rock exposures are seen, with the exception of those in the brook just mentioned and the igneous mass of Lawn hill; but, from the fact that pieces of lignite, which may be torn by storms from beds which lie out to sea, are frequently seen along this shore, it is possible that a portion of the wide passage between this island and the group of islands lying along the British Columbia coast is underlaid by the Tertiary sandstones and coals.

The character of the sandstones belonging to this formation can be well seen at the points on the north shore east of Masset. Thus, at Yakan point, two miles west of Tow hill, the rocks are generally coarse greyish quartzose grits, having a calcareous cement and holding scattered pebbles. They show much false bedding and irregularity of deposition, so that the exact dip of the formation at this point cannot be accurately determined.

Thin beds of shale also occur, both grey and blackish, on the whole similar to those seen at Skonun point to the west, except that no lignite is seen here; as a whole, however, the rocks are quite distinct from those of the Cretaceous as exposed along the Skidegate shore and about the Honna river. The sandstones are often perforated by holes, apparently the work of rock borers.

The outcrops at Skonun point, about five miles east of the entrance to Masset inlet, are mostly of a grey grit with bands of shale

and conglomerate. Certain bands contain fossil shells in abundance, and plant stems occur in the shales. The rocks are seen in two ledges situated about a fourth of a mile apart and located on the beach at about half tide. At the more westerly the dip is N. 75° E. < 15°, but in the more easterly this dip swings round to N. 40° W. < 25°. The sandstone here carries a bed of lignite of fairly good quality at the surface though as the outcrop is seen only at low water but little can be said as to its actual value, and no analysis has been made. The thickness of the lignite varies at different points, but at one place is at least four feet. The bed dips northward and if the formation is regular should not reappear inland, but from the statement of the Rev. Charles Harrison of Masset, that lignite occurs in the flat country south of the beach at this place, it is possible that other deposits exist or that the bed seen on the beach is repeated by a fault, of which nothing definite can now be asserted owing to the absence of rock exposures.

The matter could be tested at small expense by hand boring as the place is easy of access from Mr. Harrison's farm, and the whole country in this direction is low.

The four-foot bed continues along the shore for several hundred yards with a course of N. 65° E., the average dip of this portion being N. 25° W. < 30°. At the most easterly point of the outcrop the dip changes, through gradual curving of the strata, to N. 50° W. < 15°-20°.

Under the mass of Tow hill, which stands at the west side of the mouth of Hiellen river, there is at low water a good outcrop of shales, the position below the mass of igneous rock which forms the hill being well seen. These shales are brown and grey and are directly capped by the bedded trap, the surface of the shales appearing as if denuded before the trap overflow. They are somewhat altered along the contact, the reddish tint being changed to grey with a hardening of the contact layers. Ten feet west of the direct capping of the trap the shales become almost black and contain a thin band of greyish sandstone and a conglomerate made up of pebbles of volcanic rock in a gritty paste, interbedded with which there is a thin sheet of black diabase.

Inland, these rocks have not been recognized, except by Dr. Dawson at a point on the Mamin river near the extreme head of the Inlet and a short distance west of the Yakoun river. Here, a thin deposit of fine-grained argillaceous shale occurs, resting on basaltic rocks and holding thin layers of lignite of no economic importance. The shale has a tufaceous character and holds obscure impressions of plants, among which a coniferous twig was recognized. It was impossible for the writer to visit this place, but from their character, as described by Dr. Dawson, these rocks somewhat resemble the lowest beds seen on

the Coldwater river in the Nicola valley, which are also of Tertiary age. Similar lignitic occurrences were reported, though not seen, in the area south of Yakoun lake, but these, also, can be of no economic importance.

The rocks of Chinookundl brook, north of Skidegate village, as described by Dr. Dawson are "hard thin-bedded arenaceous clays, grey in colour, and frequently with bedding planes covered with shining micaceous particles. There are also hard coarse sandy beds and clayey gravels, holding well rounded pebbles, associated with argillaceous lignite, and including trunks and branches of trees which are converted into coal-black lignite though still retaining their woody texture. The beds on the whole appear to be nearly or quite horizontal." The description of these beds somewhat resembles that of the Post-Tertiary deposits already described at different points along the coast.

With the exception of the ledges seen on the coast east of Masset the Tertiary rocks showed but small signs of organic remains. The collections made in 1878 by Dr. Dawson apparently comprised most of the species obtainable at this place, and may here be repeated. The determinations were made by Dr. J. F. Whiteaves and are as follows:— (Rep. Prog. 1878-79, p 87, B.)

Gasteropoda.

Mangelia? sp. indt. One worn specimen.

Nassa, sp. Unlike any of the living species on the N.W. coast.

Lunatia? sp. Test exfoliated.

Trochita or *Galerus*. Test exfoliated.

Crypta adunca, Sby. One specimen; undistinguishable from the living species. Mr. Gabb (Pal. Cal., vol. 2, p. 82) says that this shell occurs in the Pliocene and Post Pliocene of California.

Lamellibranchiata.

Solen, sp. One fragment of a large species.

Siliqua, possibly the young of *S. patula*, Dixon. Two examples.

Standella. Very like *S. planulata*, Con., and *S. falcata*, Gld., but smaller than either. Several specimens.

Macoma nasuta, Conrad. Two or three specimens. According to Gabb (Pal. Cal., vol. 2, p. 93) this recent species occurs also in the Upper Miocene, Pliocene and Post Pliocene of California.

Mercenaria. Mr. W. H. Dall thinks this shell is closely related to his *M. Kennicotti*, from Alaska.

Chione, sp. indt. Two specimens.

Tapes staminea, Conrad. The most abundant shell in the collection. It is abundant, in a living state, on the N.W. coast, and Mr. Gabb says that in California it is found in the Post Pliocene, Pliocene and Miocene.

Saxidomus. Species undistinguishable. The outer layer of all the specimens, which are not numerous, is entirely exfoliated.

Cardium. One exfoliated valve. Appears to resemble *C. islandicum*.

Cardium. Several valves of a species which may be referred to *C. blattum*, Gld.

Arca microdonta, Conrad. An extinct species, found so far only in the Miocene and Pliocene of California. Two specimens.

Axinea. Possibly a form of *A. patula*, Conrad, but barely distinguishable from the smooth form (var. *Subobsoleta*, Carpenter) of the living *A. septentrionalis*, Middendorf, of the N.W. coast. Four single valves.

THE CRETACEOUS OR COAL-BEARING ROCKS.

The Cretaceous rocks of the island comprise a considerable thickness of shale, sandstone and conglomerate with thin limestone bands, the measurement of which, in the faulted condition of much of the strata and the absence of good sections, it is difficult to calculate. The Cretaceous rocks have an exposed breadth along the north shore of Skidegate harbour of about ten miles, namely, from the point west of Skidegate post office, or what is known as the oil works, to the old Cowgitz anthracite mine.

Northward, they extend along the eastern flank of the mountain range, composed of pre-existing igneous rocks, probably to the mouth of Masset inlet, where the village of Masset is situated; but since the greater portion of this area is covered with timber and soil, and exposures are almost entirely absent, the exact line of demarcation cannot be definitely determined beyond the fact that they do not appear to occur west of Masset inlet, with the exception of a small outlier near the south end of North island, at the extreme northwest corner of Graham island. The most northerly outcrops of this formation seen in the interior of the island were certain exposures of sandstone on the Yakoun river, about midway between the lake at the head and the upper end of the inlet; and of sandstone and conglomerate at the mouth of the Nadu river, which enters the inlet about twelve miles from the village of Masset. Similar exposures are also seen in the channel east of the large island about one mile south of the Nadu.

These outcrops help to fix the western limit of the formation, since the rocks bordering the inlet on the west are apparently all of igneous origin.

The rocks of the Skidegate shore were described in 1872 by Mr. James Richardson, when he visited the Cowgitz mine on behalf of the Geological Survey, and later, (1878) by Dr. G. M. Dawson. Large collections of fossils were made by both parties, and were supplemented (1895-97) by Dr. C. F. Newcomb. These collections were examined by Dr. J. F. Whiteaves, and the results of his work were published in several bulletins on "Mesozoic fossils" from 1876 to 1900.

At Skidegate village, there is a large area of igneous rocks comprising diabase, felsite, agglomerate, etc., which have been described by Dr. G. M. Dawson as older than the Cretaceous. These rocks extend from the point northeast of the Indian village as far west as the point beyond the oil-works at the post-office, a distance along the shore of about three miles. These are probably the oldest rocks on the island, unless we except certain small areas of sandstones, shale and limestone which occur on several islands in Skidegate harbour, and also near the west entrance of Skidegate channel. These may be of Triassic age.

The structure of the sandstone, shale and conglomerate, which are the rocks of the Cretaceous formation along the coast west of the oil-works point, is quite simple. These rocks lie in the form of two synclines, separated near the mouth of the Honna river by a low anticline which extends from the shore northwest up the valley of that stream. The lower beds which rest on the igneous rocks on the east side of this basin are somewhat coarse sandstones with interstratified beds of shale, generally greyish, but sometimes blackish-grey. The sandy beds contain scattered pebbles of igneous rocks, sometimes of large size, mostly of a fine-grained diabase. The dip of the sediments for several miles is about S. 30° W. < 20° 30'. Ribbed shells, (*Inoceramus*) are found in some of the beds, and the lists of fossils collected at different times will be found in Mesozoic Fossils, vol. I, pt. IV, 1900, pp. 305-07, by Dr. J. F. Whiteaves. Owing to the general strike of the beds in the eastern part of the shore section almost directly across the beach, and the unequal weathering of the shales and hard beds, this part of the shore is somewhat rough; but going west the sandy beds gradually decrease, and shales with occasional bands of ochreous dolomite come in and extend beyond the mouth of the Honna river. The dip of these beds, for a mile or more west of Maple island, is west, or varies a few degrees to the north or south, at angles of five to ten degrees. Approaching the small point a quarter of a mile east of the Honna gradually inclines to the north and at one place is N. 10° E. < 7°

showing the presence of a low anticline. In this stretch several dikes of fine-grained diabase cut the strata in a direction of N. 50° - 75° E. These dikes are from two to three feet thick and sometimes stand up as walls along the beach.

Approaching the mouth of the Honna, which enters the harbour inside Lena island, the dip of the shales, which, on the small point east, is to the north at an angle of 30 degrees, gradually swings round to southwest $<30^{\circ}$ - 40° . A fourth of a mile west of the mouth of the river, near the commencement of the Narrows separating Lena island from Graham island, a heavy mass of conglomerate comes in and forms high hills to the north and a rough shore for some hundred yards westward. This rock also appears on the west side of Lena island. It separates the lower series of shales, just described, from what has been called the "upper shale and sandstone series" by Richardson and Dawson. It conforms in dip with the underlying shales and is an integral part of the series. In the lower part, it contains beds of grey grit which, by the addition of pebbles, soon passes into conglomerate proper.

The pebbles in this rock are of all sizes, and comprise granite, diabase, sandstone and shale. The conglomerate extends along the shore past the Narrows for half a mile, and then passes up into the upper series. The rocks of this upper series closely resemble portions of the lower series, and continue westward along the shore to within half a mile of Slate Chuck creek. The intervening upper shales, about midway of this distance, show a synclinal structure. They are usually greyish, but in places become reddish-brown, and are sometimes thin and papery. The dip near the intermediate conglomerate is about S. 20° W. 10° - 30° .

Just west of a deep bay about one mile from the edge of the conglomerate belt the shales, which have been dipping uniformly to the southwest, show local foldings, and are probably near the centre of the synclinal just mentioned. A short distance farther on, the dip changes to the east and continues thus to within a short distance of the Slate Chuck, where the conglomerates of the Honna area again appear. As elsewhere, the slates are cut across by dikes of basalt, and traces of fossils are seen at several places. The conglomerates east of Slate Chuck contain well-rounded pebbles of igneous rocks and fragments of slate, and are evidently the equivalents of the large area of these rocks seen at the Narrows, forming here the under portion of the shale synclinal. Mixed bands of slate and conglomerate with intrusive dikes extend thence along the shore to a point several hundred yards west of the creek, where they are much faulted. At the mouth of a small creek half a mile west of Slate

Chuck creek the black and grey shales are sometimes much crushed. They become associated with heavy masses of the grey, coarse, conglomerate that forms the shore southward to the end of the tramway in Anchor cove which leads up to the Anthracite mine. This part of the shore is very rough. The rocks are much broken with occasional dips both to the east and west, and dikes of dark green diabase cut both shale and conglomerate. Between this part of the shore and the Cowgitz mine, a distance of three fourths of a mile west in a straight line, the black and grey shales again appear and are cut by dikes. The coal is in close proximity to the underlying igneous rocks which extend thence westward to the west side of the island. The rocks at the mine containing the coal are much broken up and crushed, and the original lignite of the formation has been converted to the variety of anthracite there found. This is due to heat induced by pressure of the shales and sandstones against the Pre-Cretaceous igneous rock mass at the back. In fact, so great has been the crushing strain at this place that much of the coal, when mined, is found in the form of powder, and is quite useless for economic purposes, while, as in other outcrops on the island, the coal and black shale are so closely mixed that their separation is almost impossible.

Mining has been carried on at this place at intervals for many years. The original company, apparently formed in Victoria in 1865, was the Queen Charlotte Coal Mining Co. A somewhat full description of the earlier work done at the mine is given in Mr. Richardson's report (1872) and Dr. Dawson's report, 1878-79. The last attempt to mine this deposit seems to have been made about fifteen years ago. None of these efforts has ever been attended with much success. The workings have long since been abandoned, and the tunnels having fallen in, any exploration of them at the present time would be very dangerous. In view of this fact, and because no information other than already in our possession seemed obtainable, no detailed examination of this mine was made during our visit. The approaches along the old tramroad from the wharf to the mine are already thickly grown over with bushes and will require considerable clearing before the place can be accessible.

Along the valley of Slate Chuck creek a band of sandstone with areas of black slate, more massive than the ordinary slates of the shore section, comes in and extends northwestward. As described by Mr. Richardson (Rep. Prog. 1872-73, p. 61), "the shale occurs in lenticular patches of two to three feet in the thickest part and from eight to twenty feet long which are interstratified with a light-grey, not very hard sandstone. In the patches occur an abundance of flattened stems and leaves, sometimes infiltrated with a greenish mineral and

many thin irregular patches of anthracite sometimes a tenth of an inch thick."

This is the rock from which the Indians (Haidas) of Skidegate or small totems and other interesting ornaments. A quarry has been opened in the slate by a Victoria company, and the material is shipped in the rough to that place and there manufactured. The place was visited by my assistant, Mr. S. C. Ellis, B.A., last summer and the following description, taken from his notes, may be given:—

"Slate Chuck creek is, during the summer months, a small but rapid stream, and in high water rarely exceeds thirty feet in width. From the temperature and colour of the water, as also from the comparative shortness of the stream and the rapidity of its descent, the chief source of the water supply is evidently the melting snow that caps the high ridges on both sides of the valley.

"This valley is one of the many short indentations which penetrate the mountains of the west and southwest coasts of the island. The extreme length of the valley appears to be three and a half to four miles, and the width varies from a half to three-quarters of a mile; on the east and west sides the mountains rise to elevations of 1500 to 3500 feet above sea-level.

"For about half a mile above tide-water the bed of the creek consists for the most part of drift, derived partly from sedimentary, but largely from igneous rocks. In this part of the stream are a few minor outcrops of black shale, not the soft and workable variety but a more brittle rock. From this on, the rise is more rapid, with occasional falls of five to twenty feet over ledges of slate, with agglomerate and other igneous rocks.

"About two miles from the mouth of the creek, and at an elevation of 175 feet the slate, in a soft and easily worked condition, is obtained, sometimes directly underlaid by the igneous rocks, while occasionally this, or a similar slate, occupies the bed of the stream. The slate is obtained, usually, in masses, varying in weight from a few hundred pounds to several tons. The surface of these blocks is in many cases slickensided and at times an alteration to a chloritic condition is seen. It is probable that this broken character extends downward through the main body of the slate, though in the creek bottom the slate ledges are in places quite undisturbed. Generally there is a band of agglomerate between the slates and the underlying diabase rock."

This rock was analyzed by Dr. Harrington from samples brought by Mr. Richardson, in 1872, and found to be a hydrated silica of alumina

and iron, with a large percentage of carbonaceous matter, the composition being :—

Silica	44.78
Alumina	30.94
Peroxide of iron	8.46
Lime	traces
Magnesia	"
Water	7.15
Carbonaceous matter	3.18
	100.51

A similar carbonaceous shale or rock is reported by Richardson as occurring in Wilkes' tunnel at the Cowgitz mine. The shales and associated rocks just described as occurring in the Skidegate shore section are continuous northward along the valley of the Honna river, probably as far north at least as the head of Masset inlet. They also occupy the area east of the Yakoun lake and river. West of the Cowgitz coal mine they are not seen except as a small basin-shaped area along the shores of Long Arm, which extends north from Skidegate channel as a somewhat deep inlet west of the ridge on which the Cowgitz mine is situated.

These rocks rest against the igneous rocks of the west half of the island which rise in a great series of hills to elevations of over 4,000 feet above the sea. They continue up the west shore to about the middle of the island, when the hills gradually die down and the rest of the area to North island is comparatively low or broken by scattered elevations. A similar series of hills rises east of Slate Chuck creek and include the Slate Chuck mountains, the Nipple, Mount Genevieve, etc., with elevations up to 3,600 feet. This area of igneous rocks terminates northward in Mount Etheline, 2,540 feet high, situated several miles southeast of Yakoun lake, from the summit of which, on a clear day, an extensive view which includes a large portion of the northern half of the island, can be obtained.

This high range of mountains northward from Skidegate effectually bounds the coal formation on the west. The older or Pre-Cretaceous portion underlies the sedimentaries, but the newer and more basic, often basaltic portions which form a great part of the north half of the island west of Masset inlet, are, as already indicated, probably later Tertiary, which have invaded the stratified rocks as well as the older igneous, and have in places spread over a wide area, though in the southern part they are confined largely to dikes and outcrops of limited extent. These tertiary volcanics, west of the Masset inlet, occupy a comparatively level country, broken here and there by high ridges, as in the area south of Naden harbour.

In the bed of the Honna, for several miles from the mouth, ledges of sandstone and shale are exposed at intervals, as also along the

rough trail that follows this stream for several miles and then turns off to Camp Robertson, which is about eight miles from the shore. From this camp two other trails branch off, one leading west to Yakoun lake, three miles distant, the other to Camp Wilson, about nine miles northwest.

On the Robertson trail, after leaving the Honna valley at a distance of about four miles, the hills rise steeply, and the trail crosses the eastern flank over a mass of conglomerate, which is probably a part of the ridge seen on the shore west of Honna camp. In several of the small streams that cross the trail between this and Camp Robertson, grey sandstone and shale, usually dipping at a low angle, are exposed, the angle of dip rarely exceeding ten degrees.

On the trail from this camp to Yakoun lake, similar rocks are seen on several streams which flow northward, and a ridge of amygdaloidal trap crosses the trail a short distance before the lake is reached. Near the point where the trail strikes the shore are outcrops of a coarse yellowish grit which extends along the shore for several hundred yards. It holds scattered pebbles of quartz, bluish grey felsite, etc., and while bedding planes are somewhat obscure has an apparent dip of east $< 8^\circ$. These grits seem to represent the lowest beds of the coal formation at this place and to rest against the igneous rocks that rise steeply from the western shore of the lake. In character, they resemble the coarse yellowish grey sandstones of the Nanaimo coal basin.

Going south along the east shore of the lake from the end of the trail, these grey grits are exposed for a fourth of a mile. They here overlie hard, bluish grey, igneous-looking rocks that are probably a spur from the hill range to the south, where similar rocks are seen on Mount Etheline. South of this there are small outcrops of black shale containing a little shaly coal, with outcrops of a hard, fine-grained, green diabase, which are part of the underlying series. Still further south, and near the southeast angle of the lake, there is a small basin of coaly shale in which occurs a small deposit of impure anthracite. This was prospected some years ago by a small shaft sunk to a depth of about six feet at a point 100 feet from the lake shore. The rocks passed through were a mixture of crushed black shale and irregular stringers of impure anthracite coal which does not appear to be of economic value. Further west, between the shore of the lake and Rennell sound, along which a trail, through what is called the Rennell Sound pass, was partially cleared some years ago, small patches of fossiliferous Cretaceous shales occur, resting on the igneous rocks. Fossils from these deposits show them to belong to the upper part of this formation. They have been determined by Dr. J. F. Whiteaves, and are as follows:—

Cytheria (Caryatia) subtrigonia, Whiteaves.

Thetis affinis, Whiteaves.

Trigonia diversicostata, Whiteaves.

Inoceramus concentricus, Parkinson.

Periophinctes skidegateensis, Whiteaves.

From the area between Robertson camp and the east side of Yakoun lake the following were obtained by Mr. Robertson:—

Hoplites yakounensis, n. sp.

Thracia semiplanata, Whiteaves.

Yakoun lake has an elevation, by aneroid, of 210 feet above sea-level. The country to the north, through which the Yakoun river flows to Masset inlet, is low, but is bounded by high hills a short distance west of the lake and stream. Occasional ledges of sandstone outcrop along the river, and at a point about midway between the lake and the inlet the volcanics approach in a large spur from the main mass. The contact of the sedimentary rocks with the igneous is, therefore, not far distant from the west bank of the stream.

On the inland bays or lakes at the head of Masset inlet, the igneous rocks are everywhere exposed, either in ledges or in masses along the beach, and no trace of sedimentary rocks is seen in this direction south of the junction of the Nadu river. The valley of the river itself is densely wooded and almost impenetrable to one on foot. The only indication of sedimentary rocks in the area west of the river is a small outcrop of Tertiary shales with traces of lignite, recorded by Dr. Dawson as occurring on the Mamin river, a tributary of Tsooskatli lake, and already referred to.

In the area between the Skidegate shore and the Yakoun lake coal has been found in at least three places, besides the unimportant occurrences mentioned above. A considerable extent of country has been blocked out into townships and lots by the Government of British Columbia, so that these outcrops may be definitely located. Of these coals, the most northerly is that known as Wilson camp on lot 36, township IX; the second large deposit is on lot 20, township V, named Robertson Camp, after the discoverer of the coal field, and the outcrop of anthracite on a small brook on lot 17, township V; the outcrop of the last being on the strike of the Robertson seam, though the connexion cannot be traced across the intervening country.

The area in which these several outcrops are located is rugged and hilly. It is covered with a heavy forest growth and is intersected by several small streams that flow northward into the east branch of the Yakoun river. The surface is difficult to traverse owing to its gener-

ally " character and to the impediments from fallen timber and dense scrub. The small streams are frequently almost impassable, owing to boulders and drift timber, and great care is requisite to prevent serious accidents in traversing these.

The sandstone and shale which, with occasional outcrops of igneous, are the only rocks seen in this part of the island, are similar in many respects to those seen along the Honna shore. Fossils, generally poorly preserved, are seen in some of the beds, and indicate the general horizon of the formation as Upper Cretaceous. The conglomerate on the trail to Camp Robertson probably represents the northern extension of the similar rocks seen on the shore near the mouth of the Honna, where there is an apparent anticline which should carry these rocks northwest on their strike, or in the direction of the conglomerate outcrops on the trail near the six mile camp.

The only means of access to the mining camps at Robertson and Wilson, is by means of the trail up the Honna. This keeps close to the river for about four miles, to what is called the four-mile camp which is just at the crossing of the west branch. The rise in this distance is 220 feet, so that the fall in this part of the stream is quite rapid. Thence the trail rises quickly and passes along the east flank of a rugged and hilly country, till, in two miles, at the six-mile camp, the elevation is 900 feet, the rocks at this place being conglomerates associated with black shales and grey sandstone. From the six-mile camp the trail winds around the eastern flank of the hills at elevations varying from 830 to 960 feet, to a small brook that crosses the trail about one mile southeast of Camp Robertson, at an elevation of 900 feet. This stream named Falls brook, flows over a series of grey sandstones with bands of shale lying nearly flat; but in the next third of a mile the trail reaches the summit of a ridge at an elevation of 1150 feet about three-fourths of a mile east of the coal outcrops at Robertson camp. Thence it descends rather rapidly to 950 feet, which is the height of Camp Robertson above sea level. The distance from the shore by this trail is not far from eight miles; and the path is in places in very bad condition.

The Wilson camp can be reached by trail from Camp Robertson, a distance of about nine miles, or by following up the valley of the Honna from the four-mile camp direct. Taking the route from Camp Robertson, the trail first passes over the Robertson ridge to the north, and then descends somewhat rapidly for 600 feet in a mile and a half to the valley of the East branch of the Yakoun. It then passes across a comparatively low area, till it meets the main trail from the mouth of the Honna direct to Camp Wilson, and then rises abruptly to top of a ridge 960 feet high, or a little above the level of the other camp.

This is a short distance south of the half-way camp, and thence the trail descends in four miles to Camp Wilson, the height of which above sea level, by aneroid, is 180 feet. On the ridge, midway, hard, felsitic and diabase rocks of the older series outcrop along the trail, and were seen, also, on some of the small streams which cross to the north between the half-way camp and the coal outcrops. Parts of this trail also are difficult to traverse.

Good exposures of shale and sandstone with, occasionally, conglomerate are seen on a number of these small brooks that rise to the southwest of the Robertson trail. In places, these are cut by dikes and masses of volcanic rock and are, as a consequence, much disturbed, but where these sources of disturbance are absent the coal formation rocks lie nearly flat or dip at angles of five to fifteen degrees.

The third outcrop, marked on the plan as camp Anthracite, is on a small brook half a mile southeast of Fall brook by trail. Beds of the ordinary grey shale and sandstone are seen at the crossing, and on the stream, about 250 yards above the trail, there are other exposures of similar rock in which the coal seam is located. Work was done on this outcrop some years ago, principally by a tunnel driven into the east bank to a distance of about forty feet. The shale and coal, where opened up, were much broken, the latter, generally—from the samples seen—of impure quality, and the economic value of the deposit is small. The strike of the rocks at the outcrop is about N. 80° W., the dip east, at a high angle, but as the opening is on the east side of a steep gully it is probable that the surface rocks are somewhat displaced by the overlying mass of the hill. The overhanging wall appears to be a rotten shaly sandstone.

The rocks along this stream, which we have named Anthracite brook, were examined for some distance above this outcrop. At about 100 yards the shale and sandstone change the strike to N. 60° W., with an east dip. Several small partings or streaks of coaly matter were observed; the rocks are nearly vertical and the shale is much crushed. A few yards farther up, large ledges of bluish-grey sandstone, similar to the rock on Fall brook, are exposed in a small fall of 15 to 20 feet and dip S. 10° E. < 5° 7°. It is probable that the coal of the mine on this brook is not far from the underlying igneous rock and, as in the case of the Cowgitz mine, has been crushed by pressure and altered by heat induced by rock movements.

Going southwest on this brook toward Mount Etheline similar flat lying sandstone and shale are exposed for several hundred yards. Crossing in the same direction to the upper part of Fall brook they are again seen in broad flat ledges. The elevation of this outcrop is 1,000 feet, or 150 feet above Camp Robertson. From the upper part of this

brook, still on the same course, another stream is crossed, which flows past the eastern side of Mount Etheline and enters the East branch of Yakoun river a short distance from the lake. In this also the outcrops, similar to those on Falls brook, are apparently quite regular, but approaching the mountain which is of the older igneous rock, the measures become somewhat disturbed. To the north of Mount Etheline considerable areas of peaty land occur, with small pools and scrubby timber.

From this place an ascent of the mountain was made on the east flank. It is composed for the most part of very hard rubbly, greyish weathering felsite, somewhat flinty and occasionally with a banded structure. It is a part of the underlying Pre-Cretaceous series of the island, or what has been styled, by Dr. Dawson, the "Vancouver series." The elevation of this mountain is 2,540 feet above sea level, by aneroid.

From Camp Robertson to Yakoun lake is about three miles, the descent in this distance being 640 feet, so that the elevation of the lake should be 210 feet. The geological features of this lake basin have already been stated. On the trail, several creeks are crossed where ledges of the usual grey sandstone outcrop, the dip in the larger creek midway being N. 20 E. $< 10^{\circ}$ 12'. The rocks in this area are not steeply inclined.

Returning to Falls brook, one mile southeast of Robertson camp, the sandstone and shale in broad, nearly flat ledges extend down the stream for some hundred yards and, in places, show the presence of shells and plant stems. At about 300 yards below the trail crossing there is a fall of forty-five feet over well bedded sandstone with a dip of S. 65° W. $< 8^{\circ}$, interbedded with grey shale. This is the usual character of the coal-measure sandstone throughout the district.

A good section of the rocks near the camp is afforded on a small branch of the East Yakoun stream which flows past the camp. The openings here on the main seam consist of several shafts and tunnels which will presently be described, and the containing rocks are greyish sandstone and shale both grey and black. About ten chains east of the camp, a large bank of crushed black coaly shale is exposed, succeeded down stream by sandstone and shale, also somewhat disturbed, but with a general dip of S. 30° 40° E. Two brooks join the stream from the south near this point, both of which flow to the west of the high ridge which lies to the southeast of the camp. These both show outcrops of the ordinary grey sandstone.

The rocks along the lower part of this stream are very much broken up. Intrusions of igneous rocks are frequently seen and several

sharp anticlinals occur. Thus, a short distance below the forks of the brooks just mentioned, the shales have a dip of S. 10° W. which, in ten chains further down, changes to S. 30° W. $< 60^{\circ}$, declining in a few yards to $< 40^{\circ}$ in the same direction. There is an anticline in this part of the stream or possibly a roll in the measures. Ten chains lower down, the dip is reversed to N. 40° E. 85° showing a sharp anticline and probable fault.

From this, down stream to the forks of Falls brook, coarse and fine sandstone with greyish shales are exposed at frequent intervals. All are highly inclined at angles $< 90^{\circ}$, with much broken and faulted strata and occasional masses and dikes of newer volcanics. These tilted strata extend up Falls brook for several hundred yards, the falls being about half a mile above the forks of the stream. From this fork, down to the fork of Anthracite brook, the prevailing rock is the ordinary grey sandstone showing plant stems occasionally. These rocks are much broken up and angles of dip are high. At the forks of Anthracite brook bluish shales occur, and in a distance of fifty yards the dip of these is only eight degrees to the northeast. The shale contains numerous black, rounded concretions, having a central point of iron pyrite. The dips are irregular, and hard, broken, altered, sandstones and shale extend for 100 yards to black and grey shale with a S.W. dip 40° .

Thence down the stream for some distance outcrops are lacking, the banks being low. The descent from the mine to this place, a distance of about one mile and a half, is nearly 400 feet. The bed of the stream is in places choked with drift trees and boulders of green conglomerate, rendering walking both difficult and dangerous. Where the rocks are exposed they are usually much disturbed.

Just below a small brook from the left bank, which rises a short distance north of Camp Robertson, heavy beds of hard green conglomerate outcrop, with well banded, grey sandstone, dipping S.W. $< 50^{\circ}$, the dip changing in 50 yards to S. 60° W. $< 35^{\circ}$ and, a fourth of a mile farther, to N. $< 80^{\circ}$, the area being evidently affected by faults. A hundred yards below this, the dip is northeast, the shales are sandy and very ochreous and continue for some yards with the same dip and at an angle of 25 degrees. One hundred and fifty yards down the stream, the angle increases to 75 degrees, and the rocks are again much broken up, and at the last exposure on this stream the dip is N. 50° E. $< 50^{\circ}$. Below this to the lake the banks are usually low and show no rock exposures, with the exception of a small ledge about half a mile east of the forks of the Yakoun river. The descent to the valley of this stream where the trail to Camp Wilson crosses is about

600 feet below Camp Robertson, the distance by trail being one mile and a half.

The broken character of many of the rocks along this part of the stream, which probably affects the best section across the coal-measures in the vicinity of this camp, together with the exposures of igneous rocks in association, shows that the ground in the vicinity must be greatly disturbed. This disturbance is also seen at the outcrop of the Robertson seams near the camp, where the coal appears to be cut off sharply on the southwest by a fault, and is tilted on edge along the contact for some yards. The same tilted and crushed character in the coal bed is seen in the tunnel at the eastern limit of the coal outcrop.

Between Camps Robertson and Wilson but few rocks show on the trail. On the crest of the ridge north of the former an outcrop of grey sandstone is seen, but with this exception nothing was observed till the top of the next ridge between the east branch of the Yakoun and Wilson camp was reached. Here, in the bed of a small brook, igneous rocks, apparently of the underlying series, are exposed, and seem to indicate that a division exists between the seams of the two camps. On a brook that crosses the trail a short distance north of the half-way camp on lot 18, township VI, however, good exposures of sandstone and shale appear. These streams were traversed for a distance of two miles or more east of the trail, till the banks of the stream became low, and for a mile west of the trail. This stream was named Three-mile creek. West of the trail on this creek frequent exposures of sandstone, shale and conglomerate occur, associated with green diabase and hard red-brown felsitic rock. The dips vary from north to north 70° W. $< 10^{\circ}$ $30'$. The igneous rocks are well exposed for about half a mile, but above this on the stream the sandstones are more regular and have a dip of N. 20° E. $< 10'$.

From the notes of survey of that portion east of the trail the rocks are, for the most part, sandstone with fine conglomerate; an occasional dike of volcanic rock cuts these, but is rarely seen. The dips are usually low, ranging from 10 to 20 degrees. For the first mile these are a few degrees west of north, but lower on the stream the prevailing dip is northeasterly.

About twenty-four chains east of the trail, sandstone, with bands of fine conglomerate, contain particles of coal up to an inch in size, but no outcrops of coal veins were seen in the distance traversed. The formation in this direction appears to be fairly uniform, and local disturbances are rare.

The principal coal outcrops in this area are seen on Wilson creek, about three-fourths of a mile east of its forks with the Yakoun river.

The seam of coal is here exposed along the creek bottom for a distance of seven chains. It is cut off by a fault along the southwest portion of the outcrop, as in the case of the Robertson seam, the lower part of the seam being tilted on edge.

East of the outcrop, survey was made of this creek for over one mile. The rocks are sandstones with some shales, but no trace of volcanic rocks in place was observed. The dips were usually low, but low undulations were seen, though on the whole the strata were nowhere greatly disturbed. It is possible, however, that where outcrops are concealed such disturbances may occur. The country along the creek is not so rugged as in the vicinity of Robertson camp, but a high ridge, apparently of sandstone, rises to the northeast of the coal outcrop on this creek, and extends southeast from near the Yakoun river for nearly three miles.

To the northwest of the outcrop, on a small tributary of the Yakoun, there are other outcrops of shale and sandstone in which much higher dips are found; and while they conform to the general strike of the coal seam in this direction, they may also indicate the general run of the fault which is there observed. At one point near the river a band of black coaly shale was observed with a thickness of 12 to 18 inches, but the large seam of Wilson camp was not seen in this direction. The conditions for its extension to the southeast appear to be more favourable than in the case of the Robertson seam, while the quality of the coal is much superior. The thickness of this seam, as measured in the tunnel driven in from the brook is $17\frac{1}{2}$ feet, with a parting of six inches of one foot of sandstone, the upper bench showing 12 ft. 4 in. of coal. The dip of the coal in the lower part of the outcrop, or south end of the tunnel, is N. 40° E. $< 75^{\circ}$. This is near the line of the fault. The dip at the edge of the fault is N. E. $< 85^{\circ}$, but at the inner end of the tunnel has become much less, in this way resembling the outcrop of the Robertson seam.

It is impossible from surface indications to determine the exact value of this coal seam. It has been opened at one place only, on the north side of Wilson creek, by a tunnel and small shaft. The seam itself is of large dimensions and the quality of the coal is excellent. It can be traced in a course S. 43° E. from the opening for about seven chains to another small tunnel, beyond which it has not been located. The underlying rock is a grey sandstone and the over-wall appears to be practically the same; but in the creek on which the opening is made, and a short distance below, there is a heavy outcrop of dark grey shale. In the creek also, forty feet above the upper tunnel, is a bed of rather coarse conglomerate, of a brown-grey colour, resembling the conglomerate seen on the brook three miles to the

south. In character the coal of this seam does not resemble that of the Robertson camp and should be stratigraphically higher in the formation. It is an excellent gas coal with a low percentage of ash, in both these respects contrasting strongly with that from the Robertson seam. (See analyses.)

The measures seen on the brook, both to the east and west, are comparatively undisturbed, dipping usually at low angles, but with low undulations. On the brook just by the main opening, a fault—the one disclosed in the tunnel on the seam, is seen in the sandstone. The extent of this is not known but it may be small since there is no change in the character of rock on either side.

The work done on this Wilson seam consists of a small drift run in from the bank of the creek directly on the crop of the coal to a distance of 47 feet, in a direction N. 10° E., the dip of the coal bed being N.E. < 75°-80°. Midway of the distance, a shaft, 14 ft. deep, has been sunk on the coal, and from the foot of the shaft a drift was made towards the creek and at 14 ft. struck the fault already mentioned as bounding the coal on the south. A side drift was also run across the seam westward for only a few feet, so that but little work has been done on the area.

As for the coal itself, the contact with the foot wall of sandstone is, as already indicated, by a fault and at an angle of 85 degrees. The seam itself measures from the bottom upwards.

	Feet.	Inches.
Coal of good quality	4	
Grey sandstone parting	0	6
Coal of fine quality with parting of 2 inches sandstone	12	6
Sandstone roof		

The thin parting as seen in the cross drift dies out in the direction of the creek.

The analysis of this coal, as made by Dr. J. T. Donald, of Montreal, is:

Moisture	2.47
Ash	2.92
Vol. Comb	35.25
Fixed Carbon	59.36
Coke firm and coherent.	

Two chains west of this opening, on the strike of the seam, a small drift was run into the bank in search of the coal but failed to find it. It is probable that in this distance it has been displaced by the fault.

The coal at the Robertson camp presents somewhat different features as contrasted with that just described. It has been opened along the creek for a total distance, measured from the first shaft at the west end to the end of the tunnel on the east, of 295 feet on a course 127

degrees. In this distance four small shafts have been sunk and two drifts.

In shaft No. 1, which is nearest the camp, there is a large body of coal and shale, the width of which, at surface, is from 20 to 24 feet. The lower edge of the coal is vertical, resting against a grey sandstone by a fault plane. Of this entire thickness of coal and shale the portion opened up by the shaft is about as follows:—

	Feet
Coal at bottom	4
Sandstone parting	1
Coal	2
Coal with small partings of shale mixed	2

This probably represents the lower portion of two seams which appear to exist in this area, the exact relations of which are not easy to determine at one point merely. To ascertain as clearly as possible the actual conditions of the coals at this place, as to which some discrepancy of opinion exists in the several reports on the property by mining engineers, a careful examination was made.

A measured line was run from No. 1 shaft to the entrance of the tunnel on a course of 127° for 295 feet. Another shaft, to the south of the camp about 175 feet west of shaft No. 1, found no coal, probably being to the south of the line of fault which can be traced from the first shaft into the tunnel on a course S. 65° E.

The tunnel at the east end of the outcrop was driven on a course of 76° degrees for 82 feet, or at an oblique angle to the run of the coal, and later, was continued on a course of 5° for about 60 feet. In the latter course, at 10 feet, the lower seam was struck, the angle of dip at bottom being 75° degrees, indicating a fault; the dip speedily declined and in a distance of 14 feet was only 37° degrees, the coal and shales being much crushed. The thickness of this seam of coal and shale is about 12 feet 6 inches of which the amount of coal will total about 8 feet. A large part of the seam near the outcrop is badly broken up, the coal and shale being crushed together. In general character this lower seam corresponds quite closely with the lower portion of the seam disclosed in shaft No. 1.

The second or upper seam as seen in the tunnel is separated from the lower by about eight feet of shale. The dip of 37° degrees in the upper part of the lower seam decreases to 16° at the bottom of the upper seam, the measures flattening out rapidly. The inner end of the tunnel could not be reached owing to water, but the seam as measured gave

	Feet	Inches
Coal	1	3
Shale parting		1
Coal	5	0

The last is in places mixed with shale owing, apparently, to local crushing.

It would appear therefore that the two seams seen in the tunnel when traced westward to Shaft No. 1 approach each other, and the shale parting becomes much less. This feature is seen in a small shaft and tunnel No. 3, nearly midway. Here the dip of the coal at the entrance of the slope is N.15°E. < 37°, agreeing with that of the top of the lower seam at the tunnel, with a bunch of coal next the foot-wall, but this part of the seam was not proved at a lower depth. Then come black and brown shales to the back of the tunnel, a distance of about 15 feet, when the tunnel turns to the right and continues for 15 feet more. This is in coal, the thickness of which could not be ascertained, but 30 inches could be seen. The dip appears to incline to the east, and decreases in angle, so that it appears the principal excavation here in No. 3 is above the lower seam seen in the tunnel, and penetrates the upper seam without passing through it. It thus tends to confirm the identity of the two seams at this camp.

In view of the fact that a considerable sum of money has been spent at this place, it is to be regretted that its expenditure has not been carried out on a more scientific basis, since far more intelligible results as regards the structure of this part of the field should have been obtained. The difficulty of bringing in supplies and machinery from the coast with the appliances available was, however, great, and the actual location of the outcrops at a time when the whole place was densely forested was almost an impossibility. A couple of bore-holes well placed would have been more economical in the circumstances, and would have given more actual information as to the extension and condition of the coal seams that have already been located.

It will be seen from the above remarks that a large area of coal exists both at the Robertson and Wilson camps. The extension of the seams at either place can only be ascertained by borings, but it seems probable that the Robertson seams form a basin separate from the Wilson area and bounded on the east by the high ridge between the two camps. This would indicate a strong probability of finding seams in the valley of the East branch of the Yakoun. East of the outcrop of the Wilson seam, the regularity of the measures, in so far as they could be seen, indicates conditions favourable to the occurrence of coal, but in the absence of exposures such probability can only be assumed.

The extension of the Robertson seams in the valley of the Honna is also quite probable. The sandstone and shale, where seen in that area, between the mouth of the Honna and the creeks which flow west into the Yakoun, are comparatively undisturbed though the lack of

exposures here also interferes with the determination of this problem. Along the north shore of Skidegate harbour, east of the Cowgitz mine there is also an extended area of the shales, etc., of the coal formation, and while outcrops of coal itself are not disclosed at the surface, it seems possible that the anthracite of the Cowgitz mine should be found in a less altered condition at some point between this place and the igneous rocks west of Skidegate. This also is a matter to be determined by judicious boring operations.

The question of shipping facilities is also a very important one as regards the future development of this coal field. There are only three places where these can be found, viz., 1st., at Skidegate on the south; 2nd., by way of Masset inlet on the north, and 3rd., from Rennell sound on the west coast.

In the present practically unsurveyed condition of these termini but little can be said as to choice of route, but in any case a railway will have to be built in order to reach a seaboard.

The conditions for the occurrence of lignite in economic quantities from the Tertiary rocks of the eastern portion of the island are not very favourable. There are no shipping ports available on the east side, while the presence of the lignite itself has only been ascertained on the north shore east of Masset below high water mark. The statement is, however, made by Rev. C. Harrison to the effect that the lignite exists in the flat country adjacent to the south, but no information as to quantity or quality can be ascertained. In fact, to determine actual conditions in this respect, a systematic series of borings will have to be made under proper direction at well selected spots.

The analysis of the coal from the Robertson seam shows it to differ in a marked degree from that of Camp Wilson. From a specimen examined by Dr. J. T. Donald of Montreal the following result was obtained:—

CAMP ROBERTSON, LOWER SEAM, 1905.

Moisture	1.33
Vol. com.	35.25
Fixed carbon	48.89
Ash	20.85
	100.00

An analysis of the coals from the seams at Camps Robertson, Wilson and Anthracite, from samples furnished Dr. G. M. Dawson by the first explorer of the area, Mr. W. A. Robertson, gave the following results:—

	Water.	Vol. Combust.	Fixed Carbon.	Ash.
Camp Robertson..	0.80	23.27	51.39	24.54
Camp Wilson.....	1.06	43.48	46.01	9.45
Camp Anthracite..	1.52	8.69	80.07	9.72

An analysis of the coals from these two camps from specimens obtained during the past summer has been made by Mr. M. F. Connor in the laboratory of the Geological Survey and is as follows:—

	Camp Robertson.	Camp Wilson.
Moisture.....	1.20	1.91
Volatile matter.....	29.13	35.24
Fixed carbon.....	47.52	59.39
Ash.....	22.15	3.46
	100.00	100.00

No. 1 yields a firm coke and yellowish-grey ash.

No. 2 yields a more friable coke and ash of a light red tint.

(Signed) M. F. CONNOR.

Feb. 3, 1906.

An analysis by Dr. Harrington of the anthracite from the Cowgitz mine, from specimens collected by Dr. Richardson, gave:—

Water.....	1.62
Vol. Comb.....	5.02
Fixed carbon.....	83.09
Sulphur.....	1.53
Ash.....	8.76

A second sample from the so-called 3-foot seam gave:—

Water.....	1.89
Vol. comb.....	4.77
Fixed carbon.....	85.76
Sulphur.....	0.89
Ash.....	6.69
	100.00

A sample from Camp Anthracite inland gave:—

Water.....	1.52
Vol. comb.....	8.69
Fixed carbon.....	80.07
Ash.....	9.72
	100.00

As for the probable occurrence of coal in the Cretaceous area outside of the territory possessed by the Victoria syndicate, which controls some 30,000 acres to the east of Yakoun lake, it can only be said that there is no apparent reason why seams of coal which may be the extension eastward of those already known to exist on the property of that com-

pany, may not exist. Owing however to the difficulty of obtaining outcrops over the greater portion of the district, such exploration to determine the presence of coals in workable quantity can only be economically carried on by means of boring, in which case the cable drill will possess some features superior to the diamond drill, owing to the comparative cheapness with which it can be operated in such a wilderness country.

The only place where the Cretaceous rocks were seen outside of the principal area which extends across the eastern centre of the island was an isolated patch on the southeast corner of North island. Here, shales and sandstones with conglomerates, precisely similar to the sediments seen along the north side of Skidegate channel in the vicinity of the Honna river, are exposed along the shore for nearly a mile. They dip generally S. 50° E. < 30°-40° with a roll midway to where the dip is changed for 100 yards to N. 60° E. At the northern end of the basin the shales pass beneath a mass of coarse greyish conglomerate which exactly resembles that at the Narrows west of Honna, and which there marks the base of the upper series of shales and sandstone of Richardson. These conglomerates contain pebbles of granite, hard fine-grained diabase; hard altered slate, quartz etc., with interstratified beds of coarse grits. These beds extend southeastward to the eastern entrance of the main channel between the two islands but here they are badly mixed up with the later Tertiary eruptive rocks. In this area their distribution has been defined by Dr. Dawson, (Rep, 1878-79.) No trace of coals was seen in this area, which is very limited, and apparently of no economic importance.

IGNEOUS ROCKS.

The rocks of the west coast, and in fact of the greatest portion west of a line drawn from the mouth of the Honna to Masset, are included under the head of Igneous. These are divisible into two classes, viz., those of Pre-Cretaceous and those of the later Tertiary. The former are the extension of the coast rocks of Vancouver Island and the greater part of the southern islands of the Queen Charlotte group, named by Dawson the "Vancouver series." They comprise large areas of green, generally fine-grained, diabase, felsitic rocks, sometimes porphyritic, agglomerates, etc., with which in places are limestones which contain traces of fossils, though generally of but little value for determination of horizons. These igneous rocks are the oldest known on this part of the coast. They certainly underlie the Cretaceous rocks which have just been described and may therefore be regarded as older than that series. They are penetrated by dikes and sometimes by large masses of granite, as well as by blackish green diabase rock which is more recent than the Cretaceous shales.

In these rocks, which come across from Moresby island, traces of copper were observed at several points. The mineral wealth of the series however appears to be small, and nothing of importance was seen in any part of the island. These rocks occupy the southern portion of the western half of the island to the vicinity of Hippa island, when the country becomes gradually lower and the rocks of the second series appear in increasing volume.

The second group of igneous rocks is for the most part of the age of the later Tertiary. They not only cut the Cretaceous shale and sandstone but in places rest upon the Tertiary sedimentary shales, as at Tow hill and several other points. They are generally basic, often basaltic, dark green somewhat rough trap rocks, in places showing an apparent bedded structure but roughly divided into four square blocks. In places, as at Tow hill, the lower portion of the mass, which has a height of 275 feet, is bedded in sheets or layers of one foot to eighteen inches thick, while the upper part is of the columnar variety to the top of the exposure.

The columnar form is well seen at a number of places along the northern half of the west coast, and at some points on the southern sea-board, as along the western entrance of Skidegate channel. In the island of Masset inlet, volcanic conglomerates are met with, frequently interbedded with columnar trap flows, and at one island near the lower end of the inlet expansion the rocks contain masses of obsidian. The northern portion of this inlet expansion, from the entrance past the Big island to the head beyond the Ain river, shows frequent exposures of the later diabase, which cuts across the Pre-Cretaceous igneous rocks and forms large masses. In places these bedded newer volcanics strongly resemble at a distance roughly bedded sandstones, but their crystalline character is easily recognized on closer inspection. No minerals of economic importance were seen in the rocks of this newer series.

On the west shore of the island between Frederick island and Tiahn point, a distance of about ten miles along the coast, these rocks are well exposed and form a very large portion of the shore. An interesting occurrence in this locality is the presence of thickened petroleum, now in the form of a viscous tar which fills cavities in the blackish diabase and which, when the rock is broken, can be drawn out into strings. There are no indications of sedimentary rocks anywhere in the area. About ten miles in length of this part of the coast was taken up as a mining district during the past summer (1905), the object being a search for petroleum. The preliminary investigations were not attended with any great measure of success.

of
e
s
r-
l,
d

e
d
s
o
e
a
o
y

e
a
y